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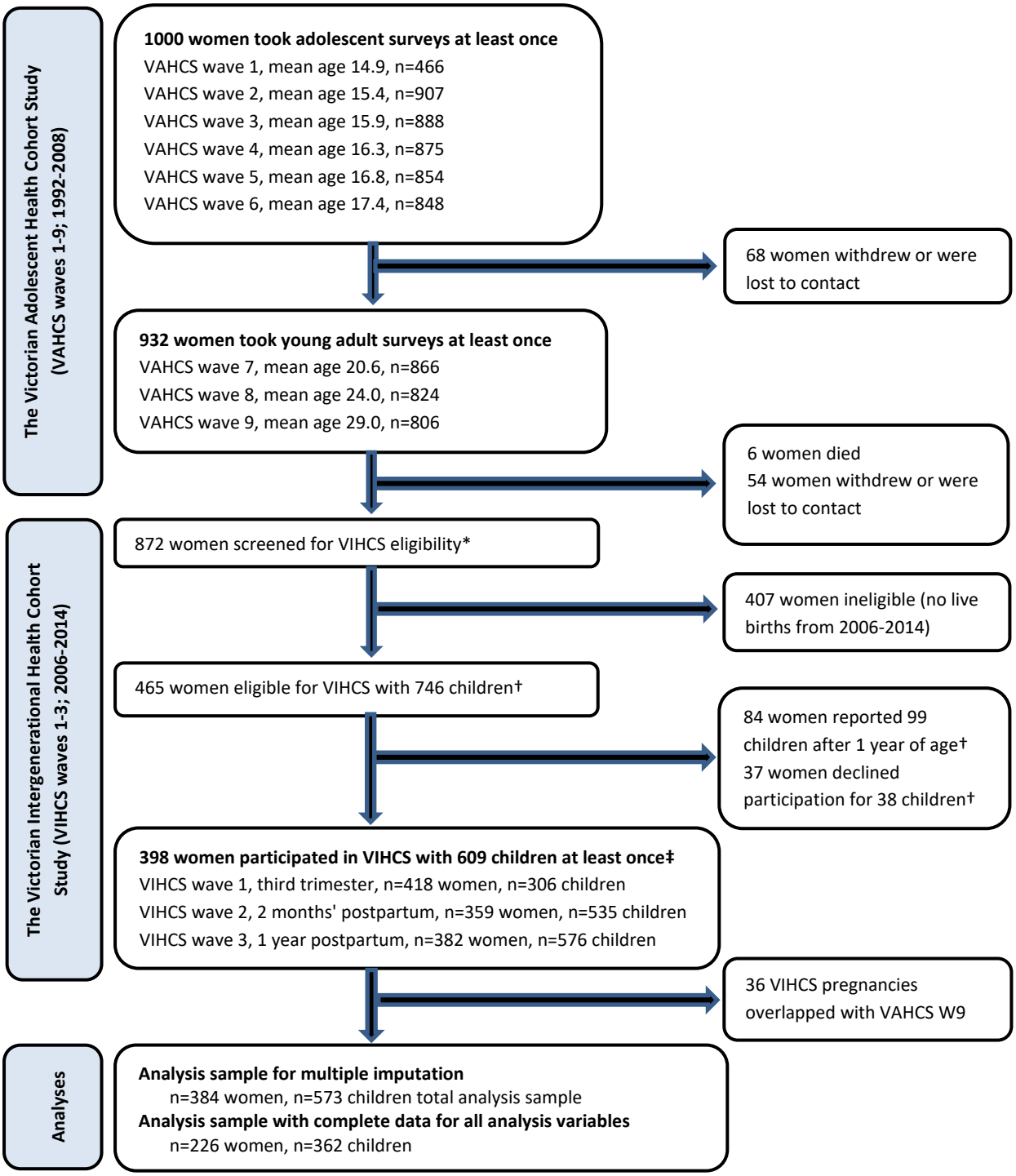
Figure 1. Sampling and ascertainment of women in The Victorian Adolescent and Intergenerational Health Cohort Studies (VAHCS and VIHCS), 1992-2014.



Using a two-stage sampling procedure, 1943 mid-secondary school students in Victoria, Australia were recruited from an identified pool of 2032. Of these, 1000 were women and are the focus of this study. Participant entry into VAHCS was staggered across Wave 1 and 2. *VIHCS inclusion criterion: at least one live birth between 2006 and 2014; VIHCS screening and assessments occurred continuously from 2006-2014 in order to identify all infants born to VAHCS women during that time and assess women as each infant reached approximately 32 weeks' gestation (Wave 1), 2 months' postpartum (Wave 2) and 1 year of age (Wave 3). †Women were invited to participate for each child born during the recruitment phase, resulting in many women participating with more than one child. Of those reporting a child after 1 year of age or declining participation for a child, only 67 women were excluded completely from VIHCS; the remainder participated with one or more other children born during the recruitment phase. #36 pregnancies to 36 women were conceived around the time of VAHCS Wave 9, and were excluded from this analysis to distinguish preconception mental disorder from antenatal mental health problems; of these, 20 women were retained in the analysis sample with one or more other pregnancies.

Missing data

The proportion of participants missing all adolescent or all young adulthood waves for either self-harm or mental health problems was low (<5%). Summary variables were created for adolescent and young adulthood self-harm, and were coded to indicate presence of self-harm if this was reported at any wave during that period. For cases where one or more waves were missing, it was assumed that self-harm was absent if no self-harm had been reported in any of the non-missing waves. Summary variables for adolescent and young adult mental health problems were created using the same process. Additional analyses were conducted to explore alternative methods of handling missing data within these summary variables (Supporting Information Page 7).

After the summary variables had been created, 226/384 women (58.9%) had complete data for all analysis variables. For the exposure variables (adolescent and young adult self-harm) and all potential confounding variables, the proportion of missing data was below 5%. A total of 363 women (94.5%) had complete data for all the exposures and all the potential confounders. However, missing data were more common among the outcome variables. 176 pregnancies included in the VIHCS cohort (31.2%) had missing data for the EPDS during pregnancy, 65 (11.5%) had missing data for the EPDS at 2 months postpartum and 31 (5.5%) had missing data for the EPDS at 12 months postpartum. Overall, EPDS data were complete for 366 (64.9%) of pregnancies in the sample, 124 pregnancies (22.0%) had missing EPDS data at one time point only and 74 (13.1%) had missing EPDS data for two of the three time points. All pregnancies had observed EPDS data for at least one time point. For the PBQ, 68 (11.9%) had missing data at 2 months postpartum and 30 (5.2%) had missing data at 12 months postpartum. PBQ data were complete for 487 (83.4%) of mother-infant pairs, 92 (16.1%) were missing the PBQ at one time point and three (0.01%) had missing PBQ scores at both time points. These missing data were largely a consequence of the design of the VIHCS study, with some pregnancies identified too late for women to participate in the antenatal or early postnatal phase.

Table 1: Proportions of missing data in analysis variables

	Missing data; n (%)
Participant level variables (total n=384)	
Adolescent self-harm	16 (4.2)
Young adult self-harm	2 (0.5)
Adolescent mental health problems	0 (0.0)
Young adult mental health problems	2 (0.5)
Parental divorce/separation	0 (0.0)
Parental education	5 (1.3)
Pregnancy level variables (total n=564)	
EPDS	
32 weeks gestation	176 (31.2)
2 months postpartum	65 (11.5)
12 months postpartum	31 (5.5)
Primiparous	0 (0.0)
Child level variables (total n=573[a])	
PBQ	
2 months postpartum	68 (11.9)
12 months postpartum	30 (5.2)

[a] *Mother-infant bonding was assessed for each infant from multiple births, so the total number of children was greater than the total number of pregnancies*

Characteristics of participants with missing data

The characteristics of participants with and without missing data are shown in Table 2.

Characteristics of women with some missing data were highly comparable to those with no missing data, although some differences were observed. Those with missing data were more likely to have parents with less than high school education and less likely to have parents with a university education. Women with missing data also had lower PBQ scores at 12 months postpartum. Data are described as missing at random if the probability of data being missing is a function of observed data. The plausibility of this assumption was examined variable by variable.

The design of VIHCS study means that the majority of missing antenatal EPDS data, the variable with the most missing data (31.2%), occurred due to the timing at which women's pregnancies were identified (i.e. if women's pregnancies were identified after 32 weeks' gestation, these data would be missing). This increases plausibility of missing at random for this variable, as the timing of identification is unlikely to be determined by women's depressive symptoms. There was also some missing data for postnatal EPDS scores (11.5% at 2 months and 5.5% at 12 months) but all participants had observed EPDS data for at least one antenatal or postnatal time point. EPDS scores at different time points were highly correlated, meaning that observed EPDS scores from other time points will be extremely valuable for imputing missing EPDS scores, again making missing at random more plausible. Similarly, 99.9% of participants had observed PBQ data for at least one of the two time points, and the scores at the two time points were highly correlated. The plausibility of missing at random is also increased by the richness of observed pre-pregnancy variables relating to mental health, including adolescent and young adult mental health problems, which had extremely low missing data.

Table 2: Comparison of key analysis variables among participants with complete data and participants with incomplete data

		Participants with no missing data	Participants some with missing data	p value
Variables collected for each woman				
Adolescent self-harm; n(%)	No	203 (89.8)	132 (93.0)	0.306
	Yes	23 (10.2)	10 (7.0)	
Young adult self-harm; n(%)	No	222 (98.2)	152 (97.4)	0.594
	Yes	4 (1.8)	4 (2.6)	
Adolescent poor mental health; n(%)	No	116 (51.3)	83 (52.5)	0.816
	Yes	110 (48.7)	75 (47.5)	
Young adult poor mental health; n(%)	No	126 (55.8)	94 (60.3)	0.381
	Yes	100 (44.3)	62 (39.7)	
Parental divorce or separation; n(%)	No	186 (82.3)	123 (77.9)	0.279
	Yes	40 (17.7)	35 (22.2)	
Parental education; n(%)	Less than high school	77 (34.1)	70 (45.8)	0.038
	High school	78 (34.5)	50 (32.7)	
	University	71 (31.4)	33 (21.6)	
Variables collected for each pregnancy				
Primiparous; n(%)	No	192 (54.2)	117 (55.7)	0.733
	Yes	162 (45.8)	93 (44.3)	
EPDS score antenatal (mean)		4.64 (3.6)	5.12 (3.9)	0.462
EPDS score 2 months (mean)		4.29 (3.4)	4.84 (4.0)	0.118
EPDS score 12 months (mean)		4.12 (3.7)	4.21 (3.8)	0.791
Variables collected for each child				
PBQ score 2 months (mean)		8.46 (7.0)	8.41 (6.6)	0.946
PBQ score 12 months (mean)		9.12 (7.1)	7.89 (6.4)	0.005

Multiple imputation model

Missing data were handled using multiple imputation by chained equations. [1] The imputation model included all analysis variables, alongside two relevant auxiliary variables (maternal age and country of birth) that were predictive of missingness and/or the missing data.[2]

A full list of variables included in the imputation model and method of imputation (for variables with missing data) is given in Table 3. Logistic regression was used to impute dichotomous variables and ordered logistic regression was used to impute ordered categorical variables. Predictive mean matching was used to impute semi-continuous variables (such as EPDS score) and continuous non-normally distributed variables. Multiple imputation was performed in Stata using 'mi impute'. 45 imputed datasets were produced, each based on 10 cycles of updates for missing values. The number of imputed datasets was based on the proportion of participants with missing data.[3] All statistical analyses were carried out on each imputed dataset separately and combined using Rubin's rules [4].

Table 3: Variables included in the imputation model and method of imputation

Analysis variables	Method of imputation
Adolescent self-harm	Logit
Young adult self-harm	Logit
Adolescent mental health problems	Logit
Young adult mental health problems	NA
EPDS score at 32 weeks gestation	Predictive mean matching
EPDS score at 2 months postpartum	Predictive mean matching
EPDS score at 12 months postpartum	Predictive mean matching
PBQ score at 2 months postpartum	Predictive mean matching
PBQ score at 12 months postpartum	Predictive mean matching
Parents divorced/separated	NA
Parents educational attainment	Ologit
Primiparous	NA
Auxiliary variables	**Method of imputation**
Maternal age at birth of infant	NA
Born outside Australia	Logit

Following multiple imputation, the characteristics of the imputed dataset was compared with the observed data, see Table 4. Characteristics were very similar for the observed and imputed data. For example, the prevalence of adolescent self-harm was 9.0% in the observed data and 8.9% in the overall dataset following multiple imputation. Mean EPDS and PBQ scores were also highly comparable between the datasets before and after multiple imputation. For example, the mean antenatal EPDS score (at 32 weeks gestation) was 4.7 in the observed data and 4.8 following multiple imputation.

Table 4: Comparison of sample characteristics between observed and imputed data

		Observed data	Imputed data
Participant level variables			
Adolescent self-harm; (%)	No	91.0	91.1
	Yes	9.0	8.9
Young adult self-harm; (%)	No	97.9	97.9
	Yes	2.1	2.1
Adolescent poor mental health; (%)	No	51.8	*NA**
	Yes	48.2	*NA*
Young adult poor mental health; (%)	No	57.6	57.6
	Yes	42.4	42.4
Parental divorce or separation; (%)	No	80.5	*NA**
	Yes	19.5	*NA*
Parental education; (%)	Less than high school	38.8	38.9
	High school	33.8	33.7
	University	27.4	27.4
Pregnancy level variables			
EPDS score antenatal (mean)		4.7	4.8
EPDS score 2 months (mean)		4.5	4.5
EPDS score 12 months (mean)		4.1	4.2
Primiparous; (%)	No	54.8	*NA**
	Yes	45.2	*NA*
Child level variables			
PBQ score 2 months (mean)		8.4	8.4
PBQ score 12 months (mean)		8.7	8.7

**No missing values so variable not imputed.*

Table 5: Associations of adolescent self-harm with perinatal depressive symptoms and mother-infant bonding problems

		Perinatal depressive symptoms (EPDS)						Mother-infant bonding problems (PBQ)					
		Partially adjusted [a]		*Adjusted model 1* [b]		*Adjusted model 2* [c]		*Partially adjusted* [a]		*Adjusted model 1* [b]		*Adjusted model 2* [c]	
		ß (95%CI)	p	ß (95%CI)	p	ß (95%CI)	p	ß (95%CI)	p	ß (95%CI)	p	ß (95%CI)	p
FIXED EFFECTS													
Young adult self-harm		1.61 (0.57 to 2.64)	0.002	1.49 (0.44 to 2.55)	0.005	1.02 (-0.04 to 2.07)	0.058	1.89 (-0.33 to 4.10)	0.095	1.74 (-0.48 to 3.97)	0.125	1.46 (-0.82 to 3.74)	0.210
Perinatal time point	Antenatal (32 weeks)	0	0.005	0	0.005	0	0.005						
	Postnatal (2 months)	-0.31 (-0.66 to 0.05)		-0.31 (-0.66 to 0.05)		-0.31 (-0.66 to 0.05)		0	0.222	0	0.222	0	0.222
	Postnatal (12 months)	-0.59 (-0.95 to -0.23)		-0.59 (-0.95 to -0.23)		-0.59 (-0.95 to -0.23)		0.33 (-0.20 to 0.87)		0.33 (-0.20 to 0.87)		0.33 (-0.20 to 0.87)	
Potential Confounders													
Parents' [d] divorce/ separation				0.52 (-0.23 to 1.27)	0.177	0.40 (-0.34 to 1.14)	0.295			0.72 (-0.89 to 2.33)	0.382	0.64 (-0.97 to 2.26)	0.435
Parents' [d] education	Less than high school			0	0.994	0	0.946			0	0.058	0	0.066
	High school			-0.03 (-0.72 to 0.66)		-0.06 (-0.74 to 0.61)				1.33 (-0.16 to 2.82)		1.31 (-0.18 to 2.80)	
	University			-0.03 (-0.74 to 0.67)		-0.12 (-0.81 to 0.57)				1.76 (0.21 to 3.29)		1.71 (0.17 to 3.24)	
Adolescent mental health problems						1.16 (0.60 to 1.73)	<0.001					0.70 (-0.59 to 2.00)	0.285
RANDOM EFFECTS		**Variance**	**S.E.**	**Variance**	**S.E.**	**Variance**	**S.E.**	**Variance**	**S.E.**	**Variance**	**S.E.**	**Variance**	**S.E.**
Woman		2.24	0.15	2.22	0.15	2.14	0.16	5.57	0.26	5.51	0.26	5.50	0.26
Pregnancy		0.91	0.27	0.92	0.27	0.92	0.27						
Time point		2.76	0.07	2.76	0.07	2.76	0.07	4.32	0.13	4.32	0.13	4.32	0.13

Models for perinatal depressive symptoms based on imputed data from 564 pregnancies in 384 women, models for mother-infant bonding problems based on imputed data from 573 mother-infant pairs from 384 women. [a] Adjusted for perinatal assessment time point only; [b] Adjusted for parents' divorce/separation and parents' education; [c] Adjusted for parents' divorce/separation, parents' education and adolescent mental health problems; [d] Parental variables refer to the parents of the mother. For perinatal depressive symptoms, a 3-level structure was assumed with repeated assessment measures nesting within pregnancies, and pregnancies within women. For mother-infant bonding problems a 2-level variance structure was used with repeated assessment measures nested within women. Variance estimated between mother-infant pairs approached zero and was removed from model.

Table 6: Associations of young adult self-harm with perinatal depressive symptoms and mother-infant bonding problems

		Perinatal depressive symptoms (EPDS)						Mother-infant bonding problems (PBQ)					
		Partially adjusted [a]		*Adjusted model 1* [b]		*Adjusted model 2* [c]		*Partially adjusted* [a]		*Adjusted model 1* [b]		*Adjusted model 2* [c]	
		ß (95%CI)	p	ß (95%CI)	p	ß (95%CI)	p	ß (95%CI)	p	ß (95%CI)	p	ß (95%CI)	p
FIXED EFFECTS													
Young adult self-harm		5.99 (3.91 to 8.07)	<0.001	5.84 (3.75 to 7.94)	<0.001	5.40 (3.42 to 7.39)	<0.001	8.05 (3.61 to 12.50)	<0.001	7.83 (3.39-12.27)	0.001	7.51 (3.09 to 11.92)	0.001
Perinatal time point	Antenatal (32 weeks)	0	0.005	0	0.005	0	0.005						
	Postnatal (2 months)	-0.31 (-0.66 to 0.05)		0.31 (-0.66 to 0.05)		-0.31 (-0.66 to 0.05)		0	0.221	0	0.222	0	0.222
	Postnatal (12 months)	-0.59 (-0.95 to -0.23)		-0.59 (-0.95 to-0.23)		-0.59 (-0.95 to-0.23)		0.33 (-0.20 to 0.87)		0.33 (-0.20 to 0.87)		0.33 (-0.20 to 0.87)	
Potential Confounders													
Parents' [d] divorce/ separation				0.46 (-0.26 to 1.19)	0.211	0.38 (-0.31 to 1.06)	0.280			0.60 (-0.98 to 2.19)	0.453	0.52 (-1.05 to 2.10)	0.513
Parents' [d] education	Less than high school			0	0.985	0	0.774			0	0.058	0	0.038
	High school			-0.05 (-0.71 to 0.62)		-0.06 (-0.68 to 0.56)				1.31 (-0.16 to 2.77)		1.29 (-0.17 to 2.74)	
	University			-0.05 (-0.74 to 0.63)		-0.23 (-0.87 to 0.41)				1.73 (0.21 to 3.25)		1.59 (0.09 to 3.10)	
Adolescent mental health problems						1.92 (1.39 to 2.44)	<0.001						
RANDOM EFFECTS		**Variance**	**S.E.**	**Variance**	**S.E.**	**Variance**	**S.E.**	**Variance**	**S.E.**	**Variance**	**S.E.**	**Variance**	**S.E.**
Woman		2.13	0.15	2.11	0.15	1.86	0.16	5.48	0.26	5.42	0.26	5.36	0.26
Pregnancy		0.90	0.27	0.91	0.27	0.94	0.27						
Time point		2.76	0.07	2.76	0.07	2.76	0.07	4.32	0.13	4.32	0.13	4.32	0.13

Models for perinatal depressive symptoms based on imputed data from 564 pregnancies in 384 women, models for mother-infant bonding problems based on imputed data from 573 mother-infant pairs from 384 women. [a] *Adjusted for perinatal assessment time point only;* [b] *Adjusted for parents' divorce/separation and parents' education;* [c] *Adjusted for parents' divorce/separation, parents' education and adolescent mental health problems;* [d] *Parental variables refer to the parents of the mother. For perinatal depressive symptoms, a 3-level structure was assumed with repeated assessment measures nesting within pregnancies, and pregnancies within women. For mother-infant bonding problems a 2-level variance structure was used with repeated assessment measures nested within women. Variance estimated between mother-infant pairs approached zero and was removed from model.*

Additional analyses

Coding summary variables

Adolescent and young adult self-harm and mental health problems were included as summary variables in the imputation model, as the imputation did not converge with all individual waves. In the main imputation model, a conservative approach was taken to the prevalence of these characteristics. If one or more individual waves were missing for either period (adolescence or young adulthood), and all observed waves during that period indicated an absence of the characteristics (self-harm or mental health problems), then the summary variable for that period was also coded to show that this characteristics was absent. Participants were only coded as missing for the summary variables if they were missing data for self-harm or mental health problems for every wave during the relevant period (adolescence or young adulthood). This could underestimate the prevalence of self-harm or mental health problems as participants with missing data may have been misclassified. Therefore additional analyses were conducted to examine two alternative methods of coding the summary variables for self-harm and mental health problems prior to multiple imputation.

The first alternative method coded the summary variables as missing if any waves in either period were missing. This substantially increases the prevalence of missing data, so sixty imputed datasets were produced in multiple imputation (using the same model described on Appendix page 4). The prevalence of preconception self-harm was similar based on this imputed data compared with the main analyses (10.3% vs. 9.7%), and the models for the associations of preconception, adolescent and young-adult self-harm with perinatal depressive symptoms and mother-infant bonding problems produced a comparable pattern of findings.

The second alternative method was similar to the first, however if responses indicated the presence of self-harm or mental health problems in any observed waves during adolescence or young adulthood, the summary variables were coded as "present" even if other waves of data collection were missing. This method ensures that self-harm or mental health problems are not underestimated, but may lead to bias in the multiple imputation as summary variables are then missing 'not-at-random'. Following multiple imputation (as described above) the prevalence of preconception self-harm was higher based on this method (12.6%). A similar pattern of findings were observed for the multilevel models, although associations between pre-conception self-harm (particularly for young adult self-harm) and both perinatal depressive symptoms and mother-infant bonding problems were weakened. This may be due to overestimation of the prevalence of pre-conception self-harm based on the coding of the summary variables and the potential introduction of bias in the imputation model.

Further additional analyses were conducted to explore the impact of the analytic strategy on the findings. The main analyses were repeated using data from each woman's first eligible pregnancy only, with each outcome time point (antenatal, 2 months postnatal and 12 months postnatal) modelled separately (Tables 7 and 8). These analyses were then repeated using multilevel logistic regression models with dichotomised EPDS scores (≥10) and PBQ scores (≥16) (Tables 9 and 10). Finally, all analyses were repeated using observed data only in an available case analysis (with cases deleted if they were missing one or more variables required for that particular analysis; Tables 11-13), for comparison with multiple imputation analyses.

Table 7: Associations of pre-conception self-harm with depression symptoms at 32 weeks gestation, 2 months postpartum and 12 months postpartum.

	Unadjusted		Adjusted [a]	
	ß (95%CI)	p value	ß (95%CI)	p value
Antenatal depression				
Pre-conception self-harm	2.01 (0.57 to 3.46)	0.006	1.20 (-0.30 to 2.70)	0.116
Adolescent self-harm	1.59 (0.06 to 3.11)	0.042	0.73 (-0.84 to 2.31)	0.359
Young adult self-harm	7.82 (4.87 to 10.77)	<0.001	7.02 (4.15 to 9.90)	<0.001
Postnatal depression (2 months)				
Pre-conception self-harm	1.32 (-0.02 to 2.67)	0.054	0.84 (-0.56 to 2.23)	0.240
Adolescent self-harm	1.11 (-0.29 to 2.50)	0.120	0.61 (-0.84 to 2.05)	0.409
Young adult self-harm	4.28 (1.24 to 7.32)	0.006	4.10 (1.06 to 7.14)	0.009
Postnatal depression (12 months)				
Pre-conception self-harm	2.36 (0.96 to 3.76)	0.001	1.83 (0.37 to 3.30)	0.015
Adolescent self-harm	2.39 (0.94 to 3.84)	0.001	1.87 (0.35 to 3.38)	0.016
Young adult self-harm	5.43 (2.75 to 8.12)	<0.001	4.93 (2.30 to 7.56)	<0.001

[a] Adjusted for parents' divorce/separation, parents' education and adolescent mental health problems. Analyses are based on linear regression in imputed data. Each outcome timepoint was modelled separately. Only the first eligible pregnancy for each woman in the sample was included in the analysis. Women were coded as having a pre-conception history of self-harm if they reported self-harm at any of the adolescent or young adult waves of data collection.

Table 8: Associations of pre-conception self-harm with mother-infant bonding problems at 2 months postpartum and 12 months postpartum.

	Unadjusted		Adjusted [a]	
	ß (95%CI)	p value	ß (95%CI)	p value
Mother-infant bonding problems (2 months)				
Pre-conception self-harm	2.85 (0.27 to 5.42)	0.030	2.34 (-0.34 to 5.03)	0.087
Adolescent self-harm	2.30 (-0.36 to 4.96)	0.090	1.78 (-0.98 to 4.55)	0.205
Young adult self-harm	8.70 (3.07 to 14.34)	0.003	8.11 (2.48 to 13.73)	0.005
Mother-infant bonding problems (12 months)				
Pre-conception self-harm	1.90 (-0.55 to 4.35)	0.129	1.49 (-1.09 to 4.07)	0.258
Adolescent self-harm	2.14 (-0.41 to 4.68)	0.099	1.76 (-0.90 to 4.43)	0.194
Young adult self-harm	8.54 (3.64 to 13.44)	0.001	8.19 (3.26 to 13.13)	0.001

[a] Adjusted for parents' divorce/separation, parents' education and adolescent mental health problems. Analyses are based on linear regression in imputed data. Each outcome timepoint was modelled separately. Only the first eligible child for each woman in the sample was included in the analysis. Women were coded as having a pre-conception history of self-harm if they reported self-harm at any of the adolescent or young adult waves of data collection.

Table 9: Table 7: Associations of pre-conception self-harm with elevated symptoms of depression (EPDS ≥10) at 32 weeks gestation, 2 months postpartum and 12 months postpartum.

	Unadjusted		Adjusted [a]	
	OR (95%CI)	p value	OR (95%CI)	p value
Antenatal depression				
Pre-conception self-harm	3.66 (1.60-8.35)	0.002	2.68 (1.09-6.58)	0.032
Adolescent self-harm	3.23 (1.34-7.76)	0.009	2.32 (0.90-5.99)	0.082
Young adult self-harm	33.68 (3.92-289.15)	0.001	30.21 (3.14-290.84)	0.003
Postnatal depression (2 months)				
Pre-conception self-harm	3.00 (1.17-7.70)	0.022	2.79 (1.00-7.75)	0.049
Adolescent self-harm	2.68 (0.99-7.24)	0.052	2.44 (0.84-7.07)	0.101
Young adult self-harm	8.94 (1.70-46.93)	0.010	10.50 (1.78-62.02)	0.010
Postnatal depression (12 months)				
Pre-conception self-harm	3.99 (1.63-9.80)	0.002	2.83 (1.07-7.48)	0.036
Adolescent self-harm	4.43 (1.78-11.02)	0.001	3.18 (1.19-8.49)	0.021
Young adult self-harm	6.70 (1.53-29.43)	0.012	5.28 (1.12-24.97)	0.036

[a] Adjusted for parents' divorce/separation, parents' education and adolescent mental health problems. Analyses are based on linear regression in imputed data. Each outcome timepoint was modelled separately. Only the first eligible pregnancy for each woman in the sample was included in the analysis. Women were coded as having a pre-conception history of self-harm if they reported self-harm at any of the adolescent or young adult waves of data collection.

Table 10: Associations of pre-conception self-harm with mother-infant bonding problems (PBQ ≥16) at 2 months postpartum and 12 months postpartum.

	Unadjusted		Adjusted [a]	
	OR (95%CI)	p value	OR (95%CI)	p value
Mother-infant bonding problems (2 months)				
Pre-conception self-harm	2.80 (1.29-6.07)	0.009	2.38 (1.03-5.50)	0.043
Adolescent self-harm	2.66 (1.19-5.91)	0.017	2.27 (0.96-5.35)	0.062
Young adult self-harm	8.40 (1.73-40.86)	0.008	7.49 (1.45-38.81)	0.016
Mother-infant bonding problems (12 months)				
Pre-conception self-harm	1.30 (0.51-3.30)	0.577	1.01 (0.38-2.69)	0.982
Adolescent self-harm	1.44 (0.56-3.67)	0.450	1.13 (0.42-3.01)	0.811
Young adult self-harm	3.58 (0.83-15.43)	0.087	3.01 (0.67-13.57)	0.152

Table 11: Associations of pre-conception self-harm with perinatal depressive symptoms and mother-infant bonding problems using complete case analysis

		Perinatal depressive symptoms (EPDS)				Mother-infant bonding problems (PBQ)			
		Partially adjusted model [a]		*Adjusted model* [b]		*Partially adjusted model* [a]		*Second adjusted model* [b]	
		ß (95%CI)	p value	ß (95%CI)	p value	ß (95%CI)	p value	ß (95%CI)	p value
FIXED EFFECTS									
Preconception history of self-harm		1.89 (0.89 to 2.89)	<0.001	1.34 (0.31 to 2.37)	0.011	2.01 (-0.19 to 4.22)	0.074	1.38 (-0.94 to 3.71)	0.243
Perinatal time point	Antenatal (32 weeks)	0	0.022	0	0.026				
	Postnatal (2 months)	-0.25 (-0.63 to 0.13)		-0.27 (-0.65 to 0.11)		0	0.206	0	0.164
	Postnatal (12 months)	-0.53 (-0.91 to -0.15)		-0.52 (-0.90 to -0.14)		0.35 (-0.12 to 0.89)		0.39 (-0.16 to 0.93)	
Potential confounders									
Parents' divorce/ separation [c]				0.43 (-0.35 to 1.22)	0.281			0.93 (-0.83 to 2.69)	0.299
Parents' education [c]	Less than high school			0	0.811			0	0.087
	High school			-0.23 (-0.92 to 0.47)				1.31 (-0.24 to 2.87)	
	University			-0.14 (-0.86 to 0.57)				1.70 (0.79 to 3.31)	
Adolescent mental health problems				1.16 (0.56 to 1.76)	<0.001			0.86 (-0.50 to 2.21)	0.215
RANDOM EFFECTS [d]		**Variance**	**S.E.**	**Variance**	**S.E.**	**Variance**	**S.E.**	**Variance**	**S.E.**
	Woman	5.82	0.69	5.34	0.67	32.81	3.08	32.15	3.05
	Pregnancy	0.11	0.40	0.14	0.40				
	Time point	7.66	0.38	7.62	0.38	18.35	1.03	18.39	1.04

Partially adjusted model for perinatal depression based on observed data from 542 pregnancies in 369 women, adjusted model based on observed data from 538 pregnancies in 365 women; partially adjusted model for mother-infant bonding based on observed data from 549 mother-infant pairs from 376 women, adjusted model based on observed data from 545 mother-infant pairs from 363 women. [a] Adjusted for perinatal assessment time point only; [b] Adjusted for all variables in the table; [c] Parental variables refer to the parents of the mother. For perinatal depressive symptoms, a 3-level structure was assumed with repeated assessment measures nesting within pregnancies within women. For mother-infant bonding a 2-level variance structure was used with repeated assessment measures nested within women. Variance estimated between mother-infant pairs approached zero so was removed from model.

Table 12: Associations of adolescent self-harm with perinatal depressive symptoms and poor mother-infant bonding problems using complete case analysis

		Perinatal depressive symptoms (EPDS)				Mother-infant bonding problems (PBQ)			
		Partially adjusted model [a]		*Adjusted model* [b]		*Partially adjusted model* [a]		*Adjusted model* [b]	
		ß (95%CI)	p value	ß (95%CI)	p value	ß (95%CI)	p value	ß (95%CI)	p value
FIXED EFFECTS									
Adolescent self-harm		1.58 (0.53 to 2.63)	0.003	1.01 (-0.06 to 2.09)	0.065	2.01 (-0.30 to 4.31)	0.088	1.39 (-1.02 to 3.81)	0.257
Perinatal time point	Antenatal (32 weeks)	0	0.023	0	0.028				
	Postnatal (2 months)	-0.24 (-0.62 to 0.14)		-0.26 (-0.64 to 0.12)		0	0.188	0	0.148
	Postnatal (12 months)	-0.52 (-0.90 to -0.15)		-0.52 (-0.89 to -0.14)		0.36 (-0.18 to 0.90)		0.40 (-0.14 to 0.94)	
Potential Confounders									
Parents'* divorce/ separation				0.50 (-0.28 to 1.29)	0.211			0.95 (-0.82 to 2.71)	0.293
Parents'* education	Less than high school			0	0.875			0	0.040
	High school			-0.18 (-0.88 to 0.51)				1.32 (-0.24 to 2.88)	
	University			-0.11 (-0.82 to 0.61)				1.70 (0.08 to 3.32)	
Adolescent mental health problems				1.20 (0.60 to 1.80)	<0.001			0.88 (-0.48 to 2.23)	0.204
RANDOM EFFECTS		**Variance**	**S.E.**	**Variance**	**S.E.**	**Variance**	**S.E.**	**Variance**	**S.E.**
	Woman	5.91	0.70	5.39	0.67	32.96	3.10	32.30	3.07
	Pregnancy	0.09	0.40	0.13	0.40				
	Time point	7.66	0.38	7.62	0.38	18.33	1.03	18.38	1.04

Partially adjusted model for perinatal depression based on observed data from 541 pregnancies in 368 women, adjusted model based on observed data from 537 pregnancies in 364 women; partially adjusted model for mother-infant bonding based on observed data from 548 mother-infant pairs from 366 women, adjusted model based on observed data from 544 mother-infant pairs from 362 women. [a] Adjusted for perinatal assessment time point only; [b] Adjusted for all variables in the table; [c] Parental variables refer to the parents of the mother. For perinatal depressive symptoms, a 3-level structure was assumed with repeated assessment measures nesting within pregnancies within women. For mother-infant bonding a 2-level variance structure was used with repeated assessment measures nested within women. Variance estimated between mother-infant pairs approached zero so was removed from model.

Table 13: Associations of young adult self-harm with perinatal depressive symptoms and poor mother-infant bonding problems using complete case analysis

		Perinatal depressive symptoms (EPDS)				Mother-infant bonding problems (PBQ)			
		Partially adjusted model [a]		*Adjusted model* [b]		*Partially adjusted model* [a]		*Adjusted model* [b]	
		ß (95%CI)	p value	ß (95%CI)	p value	ß (95%CI)	p value	ß (95%CI)	p value
FIXED EFFECTS									
Young adult self-harm		5.91 (3.86 to 7.96)	<0.001	5.28 (3.35 to 7.21)	<0.001	8.23 (3.75 to 12.71)	<0.001	7.65 (3.19 to 12.12)	0.001
Perinatal time point	Antenatal (32 weeks)	0	0.004	0	0.005				
	Postnatal (2 months)	-0.27 (-0.65 to 0.10)		-0.30 (-0.67 to 0.07)		0	0.291	0	0.234
	Postnatal (12 months)	-0.62 (-1.00 to -0.25)		-0.62 (-0.99 to -0.24)		0.28 (-0.24 to 0.81)		0.32 (-0.21 to 0.85)	
Potential Confounders									
Parents' [c] divorce/ separation				0.38 (-0.31 to 1.08)	0.279			0.69 (-0.95 to 2.33)	0.410
Parents' [c] education	Less than high school			0	0.835			0	0.092
	High school			-0.10 (-0.73 to 0.53)				1.31 (-0.18 to 2.80)	
	University			-0.20 (-0.85 to 0.45)				1.55 (0.00 to 3.11)	
Young adult mental health problems				1.94 (1.40 to 2.47)	<0.001			1.53 (0.25 to 2.80)	0.019
RANDOM EFFECTS		**Variance**	**S.E.**	**Variance**	**S.E.**	**Variance**	**S.E.**	**Variance**	**S.E.**
	Woman	5.36	0.64	4.23	0.58	31.37	2.91	30.36	2.87
	Pregnancy	0.05	0.39	0.12	0.40				
	Time point	7.70	0.37	7.68	0.37	18.00	0.99	18.09	1.00

Partially adjusted model for perinatal depression based on observed data from 562 pregnancies in 382 women, adjusted model based on observed data from 562 pregnancies in 382 women; partially adjusted model for mother-infant bonding based on observed data from 568 mother-infant pairs from 379 women, adjusted model based on observed data from 564 mother-infant pairs from 375 women. [a] Adjusted for perinatal assessment time point only; [b] Adjusted for all variables in the table; [c] Parental variables refer to the parents of the mother. For perinatal depressive symptoms, a 3-level structure was assumed with repeated assessment measures nesting within pregnancies within women. For mother-infant bonding a 2-level variance structure was used with repeated assessment measures nested within women. Variance estimated between mother-infant pairs approached zero so was removed from model.

1. Van Buuren S, Oudshoorn K. Flexible multivariate imputation by MICE. Leiden: TNO Prevention and Health (TNO Publication No. PG/VGZ/99.054); 1999.
2. Sterne JA, White IR, Carlin JB, Spratt M, Royston P, Kenward MG, et al. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. BMJ. 2009; 338: b2393.
3. Bodner TE. What improves with increased missing data imputations? Structural Equation Modeling: A Multidisciplinary Journal. 2008; 15(4): 651-75.
4. Rubin DB. Multiple imputation for nonresponse in surveys: John Wiley & Sons; 2004.